RELEASE 1.0

10-92 *A MONTHLY REPORT BY ESTHER DYSON* 31 OCTOBER 1992

THE TALE OF WIRELESS

by Jerry Michalski

Today's information environment ends at the desktop, the personal island of automation. Leaving that desktop is like going snorkeling: We can dive into the rest of our work lives, but we have to return often to the desk to use the phone, get messages and find shared files. Wireless links are like scuba gear: They give us far greater freedom of movement and let us contemplate activities we would otherwise forego.

Many people envision a device (or set of devices) that allows us to be in touch wherever we go, using whatever medium we want to use -- data, voice or video. If we need to be reminded about an upcoming meeting, to reschedule a flight, to find a good restaurant or to reply to a colleague's missive, these pint-sized, communications-savvy machines will help us get through the day more easily.

So far, most of the activity has been in wireless voice systems, principally interconnected cellular telephone networks that hook into the wired infrastructure. The wireless data market, with packet-data service providers such as IBM/Motorola's Ardis and wireless LAN vendors such as Motorola, has been struggling to find its footing.

But there are signs of new data markets: Many of the half-million-plus HP 95LX pocket PCs sold have been mated to pagers or two-way radio modems. More importantly, an array of new communications-intensive personal electronics products such as Apple's Newton is preparing to hit the market, targeted both at businesses and at consumers. Right now, there is no easy way for them to link into the existing infrastructure. The race is on to provide wireless capabilities that fit2 easily alongside wired systems and provide a variety of services: voice or data, slow or fast, short or long messages, indoors or out. Would-be vendors come from many industries: networking, telephone service, paging, telephone equipment, cellular, cable TV, computers and radio.

No single vendor is likely to provide seamless wireless services of all kinds -- from short data messages, to faxes, phone conversations or transmission of books or maps -- to all buyers. Instead, various vendors will ⟹

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emerge over the next five years, offering subsets of the complete services individuals and businesses want. These buyers will assemble their systems from components, frequently supported by a specific service offering in the background. That is, an individual will subscribe to a book-of-the-month service that will include a high-speed data-capture card linked to some network. Or a business traveler will buy a Newton that includes subscriptions to Fodor's travel guides and the OAG, as well as a wireless flight-information system. Or a company will contract with wireless data carriers to extend its corporate E-mail network. Devices on the market will be designed with interchangeability and independence in mind, so users won't have to worry about choosing the right technology for a given application.

In this issue we explore the wireless services that will shape our future. Most of our attention falls on outdoor data; voice is mentioned where it fits with data. We begin with three scenarios describing the way wireless services will likely shape the market, followed by a framework for understanding the market. Then we focus on companies likely to shape the wireless future (summarized across). They range from the broad, satellite-based services of Motorola's Iridium, through the outdoor services from Ardis and RAM Mobile Data and finally to indoor wireless. At the end we cover some technical details, which the technically adept or uninterested can skip.

Market dynamics

Given the underlying technology and the market forces at work, we present several scenarios for how wireless services will evolve. Although the scenarios may coexist, one of them will have to predominate in order to bring costs of service down to the point where the broad consumer market can participate.

The **Single Architecture** scenario is exemplified by the personal communications services (PCS) trial run by Bell Atlantic Mobile Systems in Pittsburgh (page 21). The cellular network moves into homes and offices, with data folded in. Pocket-sized devices can be used in any location -- at home, on the road and in the office. Most service is on licensed frequencies, and in-office service is not free: It is priced like Centrex. Many wireless devices in this scenario support integrated voice and data services, since the data technologies that succeed in this scenario piggyback on cellular service. Many of the features available to users (e.g., voice mail, call routing and fax broadcast) are on the carrier network, not the user devices. A winner in this scenario is Motorola, alongside some cellular carriers.

Free For All assumes that little or no integration occurs. Each market segment is served differently. Cordless phones reign supreme in the household, linked to the regular phone network by wired base stations but unlinked to cellular service. Two nationwide digital cellular voice systems emerge around separate standards (page 16). The vision of personal communications services never materializes. Public mobile data services are provided by RAM Mobile or a similar company, and are not linked to the voice network. Corporate data services are provided by Ardis. Paging companies expand their services to deliver electronic messages. In offices, there is limited penetration of both wireless PBX and wireless LANs, but even without airtime charges these systems remain expensive and useful service offerings are scarce. The wireless market is fragmented, with few opportunities to create large markets and drive prices down. Interconnection is possible but painful. As a result, there are few real winners among suppliers or customers.

Wild Card sees the PCS race won by an industry other than the cellular industry. One candidate is cable TV; another is the regulated side of the phone companies. Either of these could make use of its existing infrastructure to deliver innovative PCS services for homes and businesses in conjunction with a company such as Omnipoint (page 23), which emerges a winner in this scenario, alongside the Wild Card company or alliance of companies. Wireless data services could also emerge from a separate, as-yet-unknown initiative in this scenario. The losers here are the cellular carriers, whose growth is taken up by the PCS mavericks.

Select Wireless Data Suppliers

Product or service	Description	Status	Best Uses
Motorola Iridium	Global two-way voice and data	Spectrum allocated, negotiations in progress	Reach the unreachable; link unserved towns
Motorola Embarc	One-way messages to pager; connect to PC	In operation	Bring data feeds, E-mail to mobile terminals
MTel Nationwide Wireless Network	Two-way data messages; asymmetrical	Drawing board, but has Pioneer's Preference; earliest start 1994	Inexpensive messaging
Oracle/McCaw Data BroadCast Service (DBCS)	One-way, high speed "data freight" service	Drawing board; trial by end of 1993	New distribution channel; large file transfers
Ardis (IBM/Motorola)	Two-way data (4.8 Mbps)	Operating in 400 cities	Corporate field data
RAM Mobile Data	Two-way data (8 Mbps)	Early operation; 50 cities; 100 by April 1993	Corporate field data
Cellular Data, Inc. (CDI)	Two-way voice and data	Early trials finished; pilot in Colo.	Data added to voice devices
Cellular Digital Packet Data (CDPD) alliance	Two-way voice and data at 19.2 Mbps	Alliance formed; under development; earliest trials late 1993	Data added to voice devices
Motorola Altair	Wireless radio LAN invisible to users	Shipping; current release ups speed to 5.5 Mbps	Linking work groups in large open areas
Photonics Collaborate	Infrared personal area network	Just announced; one OEM for embedded version	Indoor, short-range, casual networking

The Independents. There are a couple of technologies that will fail or succeed on their own merits. These include Motorola's Iridium satellite service (page 10); the Data Freight Service from McCaw Cellular and Oracle Data Publishing (page 11), which has no clear competitors; and Photonics, which is doing innovative infrared work that complements, rather than replaces, traditional LANs (page 17).

Motorola: Wireless gurus

One company that comes up at every turn (including four entries in the table above) is Motorola. It's hard to keep all of Motorola's efforts straight: Iridium is the global satellite initiative (page 10); CoveragePlus a fleet-tracking system; Embarc the one-way E-mail broadcast system that uses NewsStream or NewsCard pagers (page 11); Ardis the two-way mobile radio data network, which it jointly owns with IBM and which can use Motorola's InfoTAC terminals (page 12); and Altair the indoor stationary microwave LAN (page 17). Add to these Motorola's deals with Apple (the Newton project), Samsung and others for personal digital assistants and pen computers; with General Magic for personal intelligent communicators; with Bell Atlantic Mobile Systems (page 21) for PCS; with In Focus Systems, for flat-panel displays (in Motif, a joint venture); and with countless others that have gone unnoticed.

Interestingly, practically all of Motorola's efforts involve licensed spectrum. While licensed spectrum means greater assurance of uninterrupted operation, it has some drawbacks. To deliver office pocket-phone systems, Motorola will have to collaborate with specialized third parties, probably cellular carriers such as BAMS. For wireless data, Motorola will have to manage the licensing process for buyers, as it is trying to do with Altair. Overall, Motorola's victory in the wireless markets depends on pushing its world-class manufacturing expertise to design ever-smaller, ever-cheaper gear, as it has already done with cellular phones.

Contrast this with Omnipoint's strategy (page 23), which is to use both licensed and unlicensed bands wherever possible, emphasizing the technical sophistication of its solution. Like Motorola, Omnipoint has partnerships across the industry. Many of the petitioners seeking PCS licenses from the FCC use Omnipoint technology.

Don't forget cable

Cable TV companies are on the move, too. Cox Enterprises, one of the largest, recently won a coveted Pioneer's Preference from the FCC for PCS services (using technology from Omnipoint, among others). Now that the FCC has granted cable companies the right to tie into the phone system, they are looking to use their systems to provide voice service. Many are converting their backbone networks to fiber optics and upgrading the rest of the system so that the existing coaxial cable can handle more functions than merely one-way video. Technology from First Pacific networks, for example, lets two-way data and voice signals coexist with video on coax. If the criterion for success in the household is establishing a high-bandwidth foothold, cable companies have a lead that the telephone companies, with their twisted pair, may not be able to overcome. Of course, cable companies do not have the sophisticated (and notoriously complex) billing systems that phone companies have. Also, surprising things are being done with twisted pair these days. The phone companies could counter cable's initiative with neighborhood-scale PCS systems. Or they could join forces.

Framing Today's Wireless Market

	Range	Voice		Data
Outdoors	Everywhere	Satellite phone		Vehicle-mounted satellite systems
		Radio telephone		
	Rural area			**Pagers**
		Cellular phones	Cellular modem	
	Metropolitan area			Mobile data terminals
Indoors	Workgroup	Wireless PBX		Wireless LANs
	Meeting room			Personal area networks
		Cordless phones		
	Up close			Remote controls

We have organized the services from those with the broadest range to the shortest, though there are overlaps. Typically, services that work anywhere -- including in the ocean or in a desert -- require high power and have a large footprint. It takes only one or two satellites to reach any spot in the continental US. Those that work at short range, such as cordless phones, use little power and have a small footprint. PCS (personal communications services), the set of low power, short range voice and data services, links low-power units to a network, which creates a large footprint, too. The use of low power permits many more users per channel.

Voice
Two unrelated segments dominate today's wireless voice market: cellular and cordless phones. There are other technologies, such as satellite systems that can handle voice, but they require heavy, stationary equipment. Radio telephones have been all but eliminated by cellular's higher capacity and lower cost and weight. Voice wireless services in the home are provided by the familiar cordless phone. In the office, cordless handsets go under the name of wireless PBXs, but they are rare. Often they provide less functionality at twice the price of desktop phones. The boundary between voice and data is seldom clean: It is possible to transmit data over the voice network (with a cellular modem, for instance), and vice versa.

Data
Again, the broadest wireless data services use satellites, such as the truck-mounted gear of Qualcomm's Omnitracs, which provides two-way communications for fleets of trucks on the road. Paging systems broadcast strong one-way signals from regional towers. This makes them particularly cost effective for broadcast (one-to-many) traffic.

Paging and satellite networks have larger footprints than the mobile data systems, which are focused on urban and densely populated areas. The best known of these is Ardis, a 50/50 joint venture between IBM and Motorola. But Ardis covers only a quarter of the US land mass, even though it claims to cover over 90 percent of business activity, and is not likely to expand dramatically. Instead, to offer broader coverage Ardis is preparing to provide the connections to other services.

Although paging and mobile data systems do reach inside buildings, they are not suited for indoor traffic, mostly because each message or packet is billable. By buying wireless local-area networks, companies can avoid such variable charges. Finally, devices such as TV remote controls (not necessarily computers) transmit data signals at close range with high reliability. Some HP printers and the ill-fated IBM PCjr sport such infrared links. Photonics is exploiting this technology, turning some of the limitations of infrared into systems it calls "personal area networks," which are optimized for short-range, casual wireless links.

Market framework, 1992

There are almost 10 million cellular phones in use in the US alone (Sweden has the largest number per capita, 7 percent vs. under 3 percent in the US). Cellular phones and cordless phones are in common use across the US. Although cellular subscriber growth is tapering off and the average monthly bill is decreasing, there is no end in sight to the wireless voice market.

Compare that to mobile data, with under 200,000 terminals in use worldwide, or wireless LANs, which have not penetrated many offices. Is wireless data really going to be as big as voice? Ultimately, integrated voice and data services, both indoors and outdoors, will be the rule. However, that's not the way the market looks today (as shown on page 5).

Until three years ago the only practical way for people outdoors to move data electronically without physically plugging into a phone line was over private wireless networks, several of which were developed for major corporations. In the mid '80s, IBM had Motorola build a network to its spec for its vaunted field service force. Federal Express built a proprietary wireless voice and data network using Motorola equipment with over 900 towers across the US just so it could track package delivery. IBM commercialized its network as Ardis (page 12), but so far, FedEx is not reselling its network to others.

Today things are only marginally improved. Individual users have to buy a cellular-capable modem, a cellular phone and an intelligent coupler and cross their fingers. Sending data over a cellular circuit is feasible, but it's time-consuming, it's expensive and it's not fun. Corporations can go that route, or they can subscribe to a mobile data service such as Ardis. But the terminals are expensive, as are the charges for transmissions. With radio modem prices around $1,500, adding an Ardis modem to a pocket PC can easily triple your hardware cost and double or triple the device's weight, seriously reducing portability. Then there's those monthly bills.... The expense has kept Ardis' user base to about 40,000 terminals so far; half of these are IBM's, which means there are only 20,000 non-captive users.

Indoors: don't pay if you don't have to

Although Ardis, paging and cellular signals can all penetrate inside buildings, they are not practical as in-building wireless solutions. The problem is obvious: With these systems users have to pay for each call or transaction. It's like Centrex vs. customer premises equipment (CPE, such as PBXes) in the phone system. In-building traffic costs money with Centrex, because the signal goes all the way to the telephone company's central office and back; if you work through equipment you own, the call creates no additional cost. The wireless voice and data infrastructure should play out similarly: Long run, most companies will pay carriers for outdoor transport, but will own their indoor wireless infrastructure. Devices will be built to use several different types of wireless communication. But, as we mentioned in Scenario One, there are some Centrex-style options possible.

To date, there is no clear winner or compelling architecture for indoor wireless connectivity. There are several vendors offering indoor wireless LANs, but each requires that you make certain tradeoffs. Motorola's Altair runs at your LAN's full rated speed, but requires substantial cabling (yes, cabling for "wireless" systems); NCR's WaveLAN runs slower than your network, and requires special software drivers; O'Neill Communications' LAWN is really just a low-speed printer-sharing network. The brightest idea we have seen on the data side is from Photonics, described on page 17. For voice, Motorola and Bell Atlantic Mobile Systems' Pittsburgh PCS trial (see page 21) has strong merit. Nobody has yet proposed an integrated solution.

Part of the problem indoors is the schism between voice and data. Vendors of wireless PBX systems so far have not addressed data capabilities, and vice versa. It will take some real innovation for a vendor to reduce or hide the complexity of current indoor communications systems. What with all the wiring in place already, attaching more "wireless" adjunct processors for voice capability and wireless terminals for data will simply confuse things, and the networks may conflict and knock each other off the air. It will also be expensive.

New devices, new requirements

Nevertheless, we believe wireless communication is a critical ingredient for useful information systems in the next decade. Forget linking desktop PCs with wireless LANs: Mobile devices with new applications will be the real reason to install wireless capabilities. Not every job requires the full power of a PC, with its attendant immobility. In fact, the majority of new users may not have PCs, laptops or notebooks at all. Personal Digital Assistants and other small gadgets that emphasize connectivity over computing will shake up the market and open new opportunities, but only if they are tightly integrated with the existing information environment. This does not mean they have to run the same operating systems, but it does mean linking into corporate messaging backbones. We say "backbones" because messaging involves more than just E-mail or transaction processing: There are also fax, voice mail, telephone and possibly video services to consider.

With the advent of cellular phones that weigh less than 10 ounces and are not detectable in a pocket, people are taking phones with them more often. It's different on the data side, which is lagging. First there were networked desktop PCs, which you could move if you needed to, but would rather not. Then came luggables and laptops, which could be moved much more often, but at most a couple times a day (e.g., from home to work and back). At this frequency of movement, breaking and reestablishing phone or even wireless LAN connections is not a headache. Notebook computers have opened the possibility of working on the train commute home, but one still uses them only while sitting.

The requirements of the next generation of wireless communications-intensive gadgets in the emerging personal-electronics market (both consumer and business) are a quantum leap beyond the needs of the occasionally connected notebook computer. When people carry active pen-driven personal digital assistants and personal communicators around with them all the time, the networks will have to keep up.

Mobility throws a real monkey wrench in the works. As people carry transmitters around, signal strengths vary widely, devices interfere with each other in unexpected ways and signals are obstructed by partitions or walls. An environment that supports highly mobile devices is far more complex than a wireless LAN. For example, most of the PC networks installed in the world today -- wireless or not -- require a system administrator to log nodes in and out as they are connected and removed (AppleTalk, a "chatty" protocol, is a handy exception). This won't do if users want to carry their gizmos from floor to floor with impunity.

Network OS vendors such as Apple and Novell are actively addressing this need. Apple has already released AppleTalk Remote, which accommodates users logging into the office network from home; it is working on other extensions to AppleTalk with features such as roving and dynamic node allocation to handle more peripatetic users. Novell is integrating technology from DataClub, a product it acquired when it bought Business Software Ltd., into future releases of NetWare. DataClub creates virtual volumes that make the network OS think a terminal is still there even though the physical device may be disconnected. Further, Novell's advanced research group is working hard to solve the thornier problems of smaller, more transient devices. On the device front, GO's PenPoint and other new operating systems are designed to hide communications technology from the users, and to recover gracefully in case of accidental disconnections.

New uses, new users

Early applications of wireless provide a taste of things to come. They include delivering news and E-mail into users' hands, as Motorola's Embarc service can do (page 11), or checking parts inventory from the bottom of an elevator shaft, which Otis Elevator does using Ardis terminals. Maybe you could receive superdistributed software demos (as described in **Release 1.0**, 7-92) via Oracle/McCaw's Data Freight (page 11), which you unlock with an authorization code backed by a credit card number. Imagine sending voice mail by dictating to your pocket device; the communication takes place in the background, without your intervention. How about vending machines reporting that they are empty; cars reporting that they have been stolen, plus their location, speed and heading? Some of this is already being done in vehicle anti-theft systems such as Lo-Jack.

> *You're in a meeting. Today, if an urgent matter arises, someone has to poke his head into the room, beckon for you, and whisper what's up. With a wireless link and a socially appropriate interface technology such as a pen, you could sit in the meeting and appear to be taking notes, but instead be receiving and responding to E-mail, scheduling requests and doing other work. (Of course, if you are the center of attention, this is rude.)*
>
> *Once you explore the possibilities opened by wireless links, your concept of your own availability will change. Why not go to OOPSLA if the Sherwood Forest project team can still consult with you easily? You could even work at the beach.*

There is room for different wireless services to provide the functions we have just described, because the tasks have different volume and frequency profiles. Getting a weather or traffic map is a larger problem than getting a short text message. A policeman may enter a license plate number and get pages of information in return. However, downloading new software or an up-date to a field repair manual can require far more transmission speed than is typical of wireless systems. The alternative is floppy disks or CD-ROM.

Opportunities for software developers abound. Carriers of voice and data services will need sophisticated billing and authorization systems. Vendors who understand the new functions in the phone network will be able to put those functions into a more compelling wireless personal communicator. System suppliers that investigate the benefits of linking the voice and data networks will find new markets, especially if they help extend the reach of existing E-mail filtering, workflow and groupware applications.

PCMCIA

Long term, many of these services will find a common denominator at the board-interface level, standardized around specifications from the PCMCIA (the Personal Computer Memory Card International Association). The PCMCIA standard (which specifies the pinout and interface protocols for interchangeable cards in three sizes, ranging from a single-slot Type I card, which is 3.3 mm thick, to the three-slot Type III design, which is 10.5 mm thick) is to mobile devices what the early AT bus specification was to desktop PCs: it gave add-in hardware developers a target that would likely result in substantial sales.

The PCMCIA standard has been enhanced to include I/O specifications; despite its name, it's not for memory cards only any more. A future system will likely have two or three PCMCIA slots: One slot will carry a 20 Mb solid-state memory or an off-the-shelf encyclopedia; another might hold a fax/modem; or slots two and three might hold a single high-speed wireless Data Freight card (page 11). Motorola recently announced it had shrunk the NewsStream pager to PCMCIA format in a product called the NewsCard. Expect to see many similar announcements at Comdex. Most of them will involve fax modems and phone lines, but some will be wireless.

If the standard-setting process doesn't stall, PCMCIA promises easily interchangeable cards across otherwise incompatible platforms in about three years. Not only that, but most cards should be "hot-pluggable:" One will be able to remove or install them while the host platform is running. Meantime, PCMCIA cards will be customized for particular platforms.

WIRELESS SYSTEMS: FROM OUTDOORS TO INDOORS

We now turn our attention to the key suppliers of wireless capabilities, emphasizing data transport, but with a preference for systems that can integrate voice and data.

SuperWAN: Iridium's global bypass

Motorola is the prime mover behind Iridium, an ambitious telecommunications project of global proportions. Iridium will let a person carrying a handheld terminal communicate from anywhere on the surface of the earth, whether on a mountain peak (where she'll probably have better reception), in a desert, on a ship or in an inner city. Early estimates from Iridium put service at $3 per minute, whether you are calling from next door or around the globe. This means you could conceivably take your handset anywhere in the world and talk to another person anywhere else in the world.

Seamless communication from portable handsets to a satellite network is no easy task. In order to make a satellite geostationary, it must be put into a high orbit (around 23,000 miles from earth). Communicating with something that far away requires powerful earth stations; the lightest such gear today is a small dish antenna with a heavy briefcase of equipment. Motorola's original design for Iridium required 77 low-earth-orbit (LEO) satellites in carefully synchronized orbits, between 400 and 500 miles up. LEOs have to keep moving to avoid falling into the atmosphere, so a given satellite passes over a stationary caller quickly. With Iridium, a session is handed off from one satellite to the next. It's sort of the opposite of using your car phone while in motion. LEOs fly low enough that dramatic improvements can be made on the earthbound transmitters: they can be handheld.

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> *Iridium is the 77th element in the periodic table, which means it has 77 electrons circling its nucleus, an elegant metaphor. Neatly enough, Iridium is a rare element on earth, but is commonly found on asteroids and meteors. Well, such harmony couldn't last forever: Recently Motorola reduced the number of satellites to 66. However, we don't expect the project's name to be changed to Dysprosium, the 66th element.*

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Motorola achieved a considerable victory at the recent WARC (World Administrative Radio Conference) in Spain, where lobbyists, negotiators and regulators agreed to set aside a band of spectrum internationally for LEO services such as Iridium. Using the same band everywhere is absolutely critical to this concept.

At first glance, Iridium looks like global bypass. After all, a country's PTT (postal, telegraph and telephone authority) may never touch the call, since it is going directly from handset to satellite(s) to another handset. Why should the PTTs play along? Well, they stand to get a portion of the revenues for the privilege of hosting the call, which is the only way Iridium will ever get off the ground. In fact, Iridium is approaching many countries for sponsorship, to help finance the venture. For countries with inadequate communication infrastructures, Iridium may well be the best way to link towns and villages to the rest of the world cost-effectively.

Bringing them into the marketplace could help those economies flourish. But of course there are many places in the world where enhancing citizens' communication with others, particularly foreigners, is not topmost on the national agenda.

Enter enhanced paging

Paging is not quite as breathtaking as Iridium. In fact, it is an industry in danger of extinction. As personal communications services of all sorts emerge, the relative usefulness of a beep will wear thin, and the carriers must find new sources of value. This they are doing in several ways: by increasing geographic coverage; by upping the ante from a beep or calling-number notification to full alphanumeric messages; by linking this alphanumeric capability to outside feeds, such as E-mail and news; and by pushing into altogether new systems under the banner of "enhanced paging."

Typical of the emerging message paging services -- though they prefer the term E-mail messaging service -- is Motorola's Embarc (yes, it's a cutesy acronym: Electronic Mail Broadcast to A Roaming Computer). Embarc couples a Motorola pager (the 3.5-ounce NewsStream) to other devices, right now the HP-95LX pocket PC. Anyone with a modem can transmit a mail message, which is relayed via Embarc's own network to the pager/PC combo. In addition to E-mail forwarding, one can subscribe to information services from USA Today, with other information providers on the way. Daily news and weather reports also come bundled with the $15 monthly subscription. Because of the one-to-many architecture of a paging system, Embarc can come in handy when a company wants an inexpensive way of notifying many people of some event.

There is one other effort worth noting in the paging realm. MTel, parent company of SkyTel, the US's largest paging system, recently won a Pioneer's Preference from the FCC to develop an enhanced paging system called the Nationwide Wireless Network (NWN). Although NWN is a two-way system, it is asymmetric: Signals are broadcast to the receivers in much the same way that paging signals work today; the replies return on the same frequency over a separate, low-power network of neighborhood receivers connected to packet data networks. Responses are made in time slots during which the high-power paging signal does not transmit. NWN uses new frequencies and technology, so MTel can't use its existing paging network, though it will be able to leverage its information systems and client base.

But what are Oracle and McCaw doing together?

Oracle Data Publishing and McCaw Cellular have entered into a marvelous scheme they call Data Freight, which they hope to have in pilot operation by October 1993. Although other companies have long delivered information to handsets by using small portions of the spectrum (such as stock quotes over the sidebands, or unused space, of an FM signal), these signals are typically slow and can't carry much information. The other, more traditional ways of distributing data are all too familiar: floppy disks or CD-ROMs over SneakerNet or the SnailMail. There's also dial-up and VSAT terminals.

The Oracle/McCaw team is pushing broadcast technology a quantum leap further by shoving information out the door at 0.5 to 1.5 megabits per second with its Data Freight service, sort of a paging system on steroids. That's not only much better than the speeds of all the other services we cover in this issue (which are closer to the speed of a slow modem), but is also close to the speeds of a decent local-area network. A big part of the speed comes from the fact that the system is one-way: The channel can be fully loaded because there won't be any of the collisions that hamper two-way traffic. This means one can rethink the kinds of messages, documents or applications that can be transmitted, which is where the term "data freight" comes in. Receiving a book, a large graphic or an application via a wireless channel now becomes sensible. Also, receiving devices can be very small, inexpensive and run for a long time on a battery charge. Very likely they will be engineered to the PCMCIA specification mentioned before.

The catalyst behind Data Freight is Dick Brass, president of Oracle Data Publishing and once the features editor of the New York Daily News. Brass left journalism to invent an electronic synonym finder and one of the first dictionary-based spelling checkers. Wang purchased the resulting company in 1983; Brass left Wang in 1985 to found his own company, General Information, which sold phone listings on disk, among other things.

In 1989, Oracle ceo Larry Ellison brought Brass in to figure out how to extend the information distribution infrastructure, and set him up in Oracle Data Publishing to implement his ideas. For information providers to expand their markets in the next decade, Brass figured, they will need a more convenient distribution channel than CD-ROMs, floppy disks and current online services. A database company -- Oracle, for one -- with a way of getting more data to users could provide such a channel, building new revenue streams separate from its product-licensing revenues.

But information providers are not the only potential supplier/customers. A software vendor might want to broadcast a new release of an application. It could simply send its software to the Data Freight broadcast engine over standard wired networks. The Data Freight system would then resend it, encrypted and compressed, over the airwaves. The signal would be useful only to registered users who have bought the receivers. With some thoughtful engineering, the software might even self-install. (Field-upgradeable software is handled today by several companies, including Motorola with some radio transceivers and by Interactive Networks, a company that has been piloting asymmetrical interactive TV for some time now.)

Two-way mobile data: Ardis and RAM Mobile

Anyone who has messed with data-over-cellular knows how unreliable and expensive it is. One problem is that cellular networks currently use analogue technology and a circuit-switched architecture. For short messages, the time it takes to establish and break a circuit can make this medium downright ugly for data transmission. Many carriers' minimum billing increments mean you pay for even more time than you use: A one-second data transmission over cellular can take fifteen seconds in all, and you could be billed for a minute or more.

As we mentioned earlier, Ardis is the commercialization of a packet-data network created in the mid-80s by Motorola for IBM service technicians. IBM paid Motorola about $100 million, and spent another $100 million to develop bulletproof network software and applications, which translates into a hierarchical, over-engineered system operating with relatively few frequencies in each of its service areas. Now Ardis is fighting an image as the high-priced alternative, although as the first supplier on the block it can afford to charge premium prices.

Some 40,000 terminals are currently in use by companies such as Pitney-Bowes, Otis Elevator, Avis, NCR and UPS (for its overnight-service white trucks; the huge fleet of brown trucks will be served by cellular carriers). But Ardis is not standing still. It is enhancing its network's speed, opening its protocols and broadening its service offerings.

Ardis is upgrading its network so that it will be able to move data at 19.2 Kbps (but only with new equipment), quite an improvement over its original 4.8 Kbps (which has an effective data-transfer rate of only 2 Kbps, after overhead). However, users will detect little improvement, since they are moving small packets and getting pretty quick response times anyway. The main impact will be more capacity and lower costs for Ardis.

Using Ardis originally required special standalone mobile data terminals such as the "brick" carried by IBM field-service reps. Now Motorola sells radio modems to install in PCs (one can be put in the IBM PCradio), or to attach outside (e.g., Motorola's InfoTAC). Earlier this year Ardis and Motorola published the specifications for their radio gear so other companies might build terminals and increase usage of the network, but so far there are no takers.

Also, Ardis is considering several grades of service to fill out the low-use portions of the day. For example, Premium Service would guarantee and confirm sub-second delivery of messages nationwide; Silver Service would still confirm delivery, only within 30 seconds or perhaps 30 minutes.

Ardis' fundamental asset is its ability to manage other physical networks, presenting a single point of contact for wireless communications. That is, Ardis controls a corporate account's wireless traffic, but the messages might be transported over another carrier's physical network, especially if the destination is outside Ardis' service area. Ardis is on the second major revision of what it calls its Service Engine, the back-end software that manages traffic and accounts for usage. Ultimately, if Ardis has done its job right, the company will be a wireless consolidator, playing clearinghouse to other physical networks and getting a cut of every transaction.

Right now, Ardis is the best bet for corporate, data-only transmissions that absolutely, positively have to get there. On Ardis, data is king. But the fact that the Service Engine does not support voice may hamstring Ardis long term, since combined voice and data services may be a prerequisite to serve the broad personal-electronics market.

RAM and BellSouth

RAM Mobile Data is building a network to compete with Ardis, with $300 million in backing from BellSouth. Ardis has a substantial head start: Where Ardis now covers the top 400 US cities, RAM has just past 50, and covers them thinly. RAM is adding capacity needed to serve its pilot-system customers, including National Car Rental, GE Consumer Service, MasterCard and British Air. National is testing 20 of RAM's mobile data terminals in Newark and Minneapolis for inventory control: It wants to cycle cars into use faster and avoid unnecessary expenses by keeping better tabs on its fleet. It could use 1,500 terminals if the pilot succeeds. RAM is providing the wireless services, the handheld terminals are from Itron and the system is being developed by EDS. RAM recently signed a notable agreement with Lotus, Novell, Word Perfect and others, who will enhance their connectivity products to support RAM's wireless network.

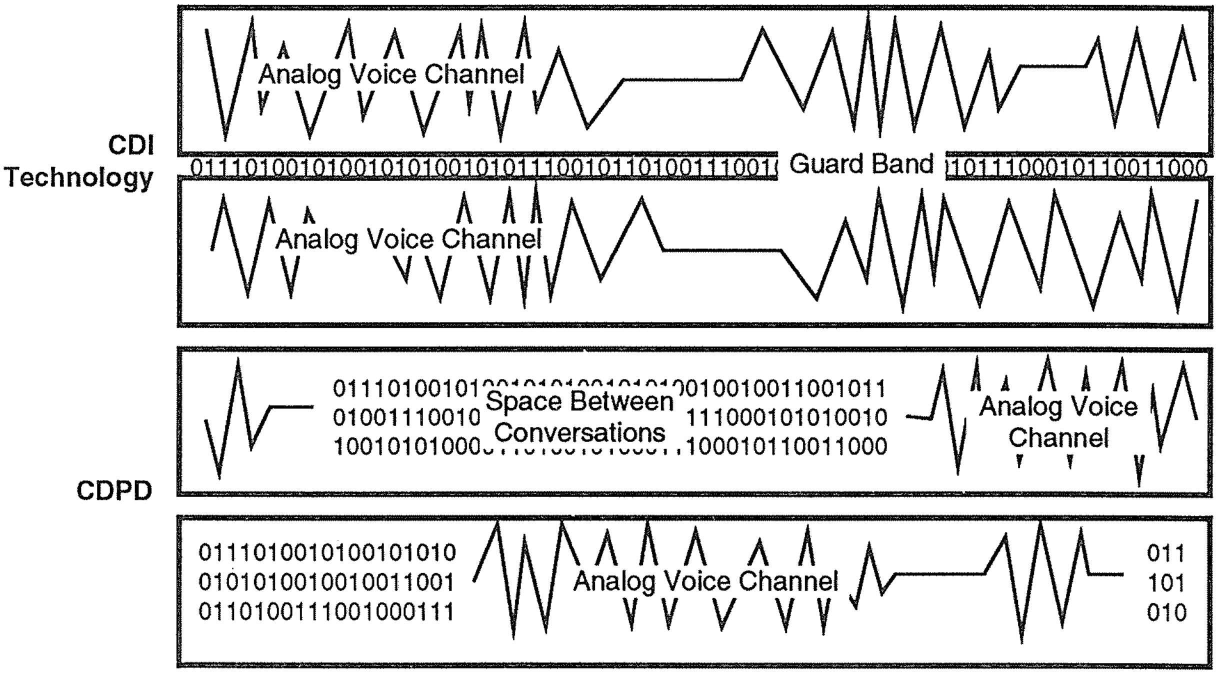
There are several appealing aspects to RAM's system relative to Ardis': RAM has 30 to 50 frequencies per city (to Ardis' four to eight), runs roughly twice as fast (at Ardis' current speed) and is based on open designs (Ardis uses proprietary protocols, which it recently published). RAM's network uses the Mobitex standard promoted by LM Ericsson and already in use for years in many European countries (albeit in completely different frequencies, which means terminals must be modified). The announcement of Mobidems from LM Ericsson gives developers a Mobitex unit comparable to the Motorola InfoTAC mentioned above. Because RAM's Mobitex architecture uses smart terminals and base stations (vs. Ardis' hierarchical model with relatively dumb terminal units), more decisions are made locally and the network can handle high local transaction volumes. Technically, RAM seems to have more capacity, but this will not matter until both networks add customers. Although RAM claims its network could handle voice as well as data traffic, it would have to petition the FCC to carry voice, since its license forbids it.

Piggybacking on cellular: CDI and CDPD

If Ardis and RAM Mobile are constrained by being data-only services, what is likely to emerge as a viable competitor for integrated voice and data? One answer is cellular systems carrying full-fledged data signals. So far we haven't talked much about cellular, even though cellular carriers currently transport most existing wireless traffic and are upgrading their systems to digital transmission technology. (See page 16.) However, the digital cellular protocols were not designed for data traffic. If nothing changes, folding data into the voice stream will remain as difficult as it is today.

During the digital-standards battles, a small company emerged with a viable way to fold data into the cellular system. Cellular Data Inc. (CDI) has been building support for its technology, which squeezes packets of data into the (currently unused) guard bands that separate the analog voice channels (see next page) to keep them from interfering with each other. Many cellular carriers are leery of messing with the guard bands, which are there to maintain call quality. The last thing they want is to lose voice revenues because they have degraded the quality of that channel. Early proof-of-concept testing by GTE Mobile Communications showed that CDI's technology works, as long as it is engineered carefully so it doesn't interfere with the voice channels.

The major appeal of CDI's technology is the low incremental cost: Because it folds into the existing cellular network (with its attendant real estate, towers, radio equipment and switching gear), the cost of deploying data is substantially lower than building a data network from scratch, as Ardis and RAM have done. At the other end of the link, in the handset, the investment is also incremental: The circuitry required to add data to a cellular handset is small in proportion to the cost of the entire unit.



Recently, IBM and all but one of the major Bell Operating Companies formed a major new alliance around a different packet-data technology. The missing member is BellSouth, which was not invited partly because of its strategic relationship with RAM Mobile Data. The alliance, built on technology from IBM's labs called CelluPlan II, goes by the name of CDPD, for Cellular Digital Packet Data. The alliance arose from the chicken-and-egg frustration that many cellular carriers felt toward wireless data communications. Which would come first, new devices that would justify wireless data networks, or the networks themselves? Or would cellular carriers just turn the data market over to Ardis and RAM Mobile?

Where CDI's approach sends packets of data in parallel to the ongoing voice channels, the CDPD system transmits data packets in the lulls between calls (see again above). So a CDPD system listens to all the available cellular frequencies, finds an empty one, and bursts a few packets into the air. The CDPD spec provides for a rich set of features and several grades of service.

CDI, with $13.5 million in venture funding (from Kleiner Perkins Caufield & Byers, among others) since its launch in 1988, has developed connections to existing X.25 networks to carry the data signals from the switching offices to host computers, which should stand it in good stead. CDI's strengths seem to be its low power consumption and its likely prevalence in other countries, particularly Singapore and its neighbors, where CDI is well along.

At this point, though, the CDPD alliance seems to have the most momentum in the US. But, just as seems to be happening with the move to digital voice, CDI's approach and the CDPD alliance could coexist. After all, they use different types of empty space in the cellular bands.

Regardless how the CDI/CDPD race turns out, it is important to note that in these systems voice traffic always rules. The cellular carriers' mission is to move voice signals; data is a mote in their eye right now, accounting for maybe 1 percent of their traffic. Even if it grows at an astounding rate, data traffic will remain small for a long time to come. Applications that require instantaneous, confirmed delivery of data messages will be better served by Ardis and RAM.

A hybrid system (with data piggybacked on cellular bands) will be typical of carriers in five years. In the meantime, carriers have their work cut out fleshing out the options that each will provide and writing the underlying software. (In contrast, both Ardis and RAM are dealing with mature system software.) Needless to say, this is a great opportunity for large software houses such as Cincinnati Bell Information Systems.

Some background on cellular technology

The US cellular carriers are in the process of migrating their currently all-analog voice systems (which use AMPS, for Advanced Mobile Phone Service) to digital technology, which greatly boosts capacity. This will principally benefit the carriers, since users will not get better-sounding connections and they will have to invest in new handsets. Two camps have formed around two major digital protocols: **TDMA** and **CDMA**. The TDMA group, led by Hughes, consists of McCaw, Southwestern Bell and Rogers Cantel. CDMA fans, led by Qualcomm, a technology supplier, are GTE/Contel, Nynex, Ameritech, Bell Atlantic, PacTel Cellular and Bell Cellular of Canada.

TDMA means time-division multiple access, and works much like time-division multiplexing in the wired-data world: Digital signals are spliced into a data stream at segments assigned to them, rather like a carousel. TDMA will leave the cellular channel spacings intact. TDMA equipment (switching gear and handsets) will be available sooner than CDMA, but TDMA has less overall capacity, so it will eventually be upgraded to Enhanced TDMA where traffic demands it.

CDMA (code division) is a special case of spread-spectrum radio technology, which we describe below, on page 23. Unlike TDMA, which keeps the channel spacings intact, CDMA consolidates the existing channels into larger bands. For a few months it seemed that TDMA would be officially sanctioned by the Cellular Telephone Industry Association, but recent events have given CDMA new life. GSM (Groupe Speciale Mobile, an incompatible TDMA variant) is the agreed-upon digital standard in Europe and much of Asia, but efforts to deliver GSM systems have fallen behind schedule, and there is no effort to implement GSM in the US.

A SHORT TRIP INDOORS

So far, all we have talked about is outdoor systems, some of which have reasonable penetration indoors, but all of which you'd have to pay for each time they are used. Indoor systems, in contrast, are usually owned by a company, which means there are (or should be) no airtime charges.

Why plan a wireless LAN?

For some time now, wireless LAN products have tried to justify their existence alongside wired networks for desktop machines, despite being more expensive at purchase time. Calculate the life-cycle cost of installing and reinstalling cabled networks, the argument went, and you'll buy a wireless network instead. But today's wireless LANs make the most sense where running cables is impossible (as in a historic building) or expensive; or where networks have to be set up and torn down for frequent relocations (as happens with audit teams, or with point-of-sale terminals in a department store). Wireless LANs will not replace their cable-bound brethren, but rather will complement them.

Motorola's Altair is one of the more interesting LAN-level products because it looks transparent to the machines it is serving. To deliver Altair, Motorola engineers took equipment that used to cost $35,000 and sit in a housing the size of a washing machine, and shrank it to the size of a desktop PC. It is, in fact, an engineering marvel, operating at licensed microwave frequencies. Motorola has procured the operating licenses and tries to make them invisible to buyers. Users still have to fill them out and mail them in to the FCC, but this is far easier than having to petition for a license. Regardless how impressive the engineering, hubs that interconnect wired subgroups are likely to remain a niche business. Surprisingly, Motorola may be able to shrink Altair further, but we won't hold our breath until then.

Part of the problem is that current wireless LAN offerings, such as Altair, BICC's InfraLAN and Windata's FreePort, are oriented toward linking groups of stationary workstations, or at best individual stationary workstations. That can be a surprise to people who begin to shop for wireless networks.

Cutting the umbilical: Photonics

Photonics may be remembered by some in the Mac world as a vendor of point-to-point infrared systems (mostly used to link buildings across a street, replacing a leased line) and shared-ceiling-space LAN systems (all transceivers are focused on the same spot on the ceiling, where each "writes" and "reads" the data stream). Well, Photonics president Gary Hughes and his staff saw increasing competition for static wireless LAN systems, and dropped the old product line. Now they are moving full-bore to deliver one of the more innovative ideas in this market. Apple is one of the investors, and Photonics' line is likely to find its way into upcoming Apple products.

Photonics' new product family is called Collaborate, and comes in several form factors. The smallest and cheapest ($150 per device, with $30 as a goal) is an OEMable infrared transceiver that PC, laptop and other device vendors can build directly into their computers' chassis; TA Triumph Adler is the first. In an inboard version, a translucent window sits over the transceiver, letting light in and out, and the Photonics technology does its business at one megabit per second. The other major form factor is a small outboard device that attaches to the back of a PC or Macintosh. This same device will be available as a standalone Access Point, providing a window onto the network for mobile users who come into range. Now, 1 Mbps is not a normal Token Ring or Ethernet speed (though it's plenty fast for vanilla AppleTalk), but then Photonics is not after LANs: It is working from a different model it calls the Personal Area Network.

A PAN turns radio's strengths into weaknesses, and infrared's weaknesses into strengths. Radio has better propagation characteristics than infrared, which Photonics would say makes it less secure. Also, radio signals are susceptible to interference from other radio emitters and even from electromechanical devices nearby. Infrared is safe and secure. And the limited range of infrared means -- says Gary Hughes -- that IS managers don't have to worry about strangers prowling their premises and capturing data: Visitors will have to be near an Access Point to get on the network at all.

One of the most interesting aspects of PAN setups is that each machine can be a peer. Two Collaborate-capable machines that meet in the hall or in a room can immediately establish a connection, and they might as well be cabled together. We foresee this kind of technology embedded in many upcoming devices. Photonics' strategy resembles that of Adobe, but upside-down: Like Adobe, Photonics wants to collect royalties from everyone by becoming the de facto way to do personal area wireless. The upside-down part is this: Where Adobe looks like a software company but must design high-performance hardware specs for its licensees to make it all work, Photonics has to do careful software engineering to sell its hardware.

In the wings...

There are plenty of wireless technologies and companies we haven't addressed in this issue, including other Specialized Mobile Radio offerings (Ardis and RAM Mobile are examples but there are plenty more), other mobile satellite systems, and airplane services such as GTE/Airfone and In-Flight Phone. Wireless also underlies some interactive TV systems, including TV Answer and Interactive Networks. AT&T has many projects up its sleeve, and is beginning to synchronize its efforts with NCR. Nor have we talked about Apple's proposal for a Data-PCS band or the Emerging Technologies Band (roughly the 200 MHz straddling 2 GHz).

Bellcore has just announced technology that lets it transmit a single video channel over an ordinary copper wire. The best that companies have been able to do so far moving video over so-called twisted pair results in artificial, stuttering images of poor resolution. Bellcore's ability to send a video signal over ordinary wiring raises the question of whether the same technology can be applied to wireless systems, perhaps leading to mobile interactive multimedia applications.

Finally, some people don't want to carry any electronic device. There are solutions for this problem, too. Voice- or fax-response technology can turn any phone and fax machine into a remote terminal and printer. Or, people could carry a smart card that turns any machine they trip across into their own computer. These questions we leave for future issues of **Release 1.0**.

WIRELESS 101

To complete the picture of wireless communications and make explicit some of the nuances, it makes sense to spend some time going over the basics. Depending on frequency, signals transmitted across space using the electromagnetic spectrum act in one of three ways when they strike objects: they can either be absorbed by, pass through or bounce off them. The principal media used for wireless communication systems are infrared light and radio waves.

Because they are a form of light, infrared signals cannot pass through an opaque object, such as a wall or partition. Instead, some of the signal will be absorbed, some reflected. On one hand, this means infrared systems are secure, since their signals can't go through your company's walls into mischievous hands. On the other hand, infrared network vendors have to be more clever to achieve the same geographic coverage as radio systems. In many cases this means resorting to ceiling-mounted infrared "satellites" or repeaters. But once you need someone to engineer a network, you've raised a barrier to implementation. This is a common theme for infrared and radio.

Outdoors, infrared is useful only for line-of-sight installations, such as a link between two buildings across a street, or a beam connecting a video truck outside a football stadium with a camera crew inside. For most applications, infrared will be useful only indoors. Once you are sheltered from the sun, you can bounce signals off the walls, ceiling and furniture and have some real fun. Clever infrared system developers such as Photonics are making use of the fact that infrared signals lose only about half their energy with each reflection. With so-called diffuse broadcast, infrared systems can blanket surprisingly large areas without repeaters or line-of-sight links. Photonics, for instance, claims its system can cover a 30-foot-square room.

Because infrared light oscillates ten trillion times per second (as opposed to several thousand to several billion for radio), infrared is farther from its limits than radio. While all of this innate capacity is not available to system designers because of technology limits, some radio systems are at the limits of their theoretical capabilities because there is simply no more frequency to use.

Much of the action in wireless these days has to do with radio, but don't count infrared out. Electrical devices throw off a magnetic field, which is why your TV goes berserk when you vacuum. Radio gear can be affected quite a bit by this kind of interference, from unexpected sources, but infrared is not susceptible to such interference. Also, while there are some doubts about the health implications of setting radio gear in a common work area, there are few such doubts about infrared. And it needs no licensing worldwide, another strong factor in its favor.

Radio, radio

In contrast with indoor-only, easily blocked infrared, most radio systems have strong penetration characteristics. NCR's WaveLAN, a wireless radio LAN system used mostly for point-of-sale terminals in stores, is good up to 800 feet, even through minor obstacles. Ardis engineers not only use frequencies with good penetration characteristics, they also designed the system with heavy overlapping coverage; this suits the in-building tasks for which customers have used that network, such as the elevator technicians we mentioned before. Other radio frequencies, such as the microwaves used by Motorola's Altair wireless LAN system (not to be confused with Ardis, which also involves Motorola), behave more like infrared, and don't pass through objects well. They may make it through thin office partitions, but not through many interior walls, never mind a solid exterior wall.

Use of radio waves is regulated, which means that broadcasters must apply for and receive a license before they can transmit. The licensing process can be tortuous, with companies' entire futures turning on an action by the FCC. With such a license, a company can count on a clear signal. But getting a license is tough: Space on the radio waves is as dear as real estate in downtown Tokyo. Here developed countries are at a disadvantage: Countries that get to build from scratch, such as New Zealand, have a leg up.

There are major changes in US spectrum assignment afoot, with the goal of making more efficient use of the resource. The spectrum reallocation may cause some existing users to share their once-exclusive bands or find new space. It is also opening opportunities for companies to enter new markets, threatening established wireless carriers. So-called "Pioneer's Preference" licenses are a short cut that the FCC grants to companies that demonstrate innovative ways of using the airwaves. Such a grant can open a three-year window of opportunity between the Pioneer and other petitioners. Several such preferences were awarded in the last couple months for personal communications and enhanced paging services. The recipients were MTel (parent of SkyTel), Omnipoint, Cox Enterprises and American Personal Communications.

Licensing has other implications. Wireless systems that use licensed frequencies must be registered. This means paperwork. Once they're installed, moving the systems may require re-registering. Installing licensed-frequency systems sometimes requires special certification, which may keep many VARs and system integrators from reselling these services, narrowing the overall market opportunity but benefiting the lucky few.

The FCC disposes...

In the US, the FCC has set aside three bands of the radio spectrum for unlicensed use (at 902 MHz, 2.4 GHz and 5.7 GHz). Broadcasters in those bands must still certify their equipment and keep their signal strength in check (under one Watt) so it doesn't obliterate or jam other broadcasters. Nobody is guaranteed transmission in these bands, so many resort to special interference-resistant techniques such as spread spectrum, described below. Most devices operating in these bands stick to very low power, but every so often a garage-door opener is triggered by passing aircraft, or a baby-watch intercom intercepts a neighbor's cordless phone conversation. This is the result of these services trying to use the same unlicensed space. The highest of the three unregulated bands is not practical for handheld devices at this time; the lowest is where most current activity is; the middle one is the emerging battlefield.

Of course, radio transceivers can be tuned to hear only specific bands, so many terminals can be broadcasting at the same time on different frequencies. Cellular carriers, which do not have much spectrum to work with, design their cell sites like honeycombs, alternating frequencies so that neighboring cells do not interfere with each other (called frequency reuse).

Also, by carefully controlling power levels of the signals, more people can share a particular frequency band.

The move toward personal communications services

You can use a conventional cellular phone indoors, but as we mentioned, you would be paying airtime charges. Besides, unless you're sitting on a cell site, reception is not as good as with wired phones. PCS (personal communications services) will remedy this problem by providing inexpensive, portable voice and data devices and services in the office, at home and outdoors.

Early PCS projects involved outbound-only handsets (called CT2, for the second generation of cellular telephony) and didn't do too well, such as the UK's Telepoint. Eliminating inbound calls makes it much easier to deliver a service, because finding users is difficult; so is handing them off smoothly as they move from cell to cell.

> *Zoe goes down to her favorite discount electronics store and gets what looks like a cordless phone. It has a handset and a base station, and she can set it up just as she would one of today's cordless phones. But wait. If she takes it out of range of the base station it will still work, by reaching out to the cellular system.*
>
> *Then she gets to work. Instead of putting the phone away, she continues to use it, because it has automatically sensed its proximity to Zoe's office wireless PBX setup. That means calls inside the office are essentially free, because the handset will not use the cellular network as long as it detects a friendly base station.*

Vendors such as LM Ericsson already sell wireless PBXes and handsets that can work in the office or on the road (though not at home without airtime charges). More services are on the way. For example, in Pittsburgh, Bell Atlantic Mobile Systems (BAMS) is piloting Personal Line, a cellular-based PCS service that uses Motorola equipment and leverages features of the increasingly intelligent public phone network. Personal Line provides a subscriber with a single handset that works at home, on the road and in the office. BAMS has been signing up subscribers (it wants 500) for a nine-month pilot that starts this December.

Personal Line customers lease a special cellular phone and base station that operates like a cordless phone at home. BAMS also installs a vehicle adapter kit for free (at least during this trial phase) to ensure proper cellular reception in the user's car, and an office microcell network, if applicable. Basic service for the pilot is $41 per month, including equipment, one-number service and voice mail; $6 more adds call blocking and screening features. At home and in small offices, users pay only for regular land-line charges. On the road, they pay cellular rates. In offices served by a special microcell system they pay 8 cents per minute plus land-line charges, a price meant to be competitive with Centrex service. Although we love the concept of PCS as demonstrated in this pilot, we think in the long run few companies will be willing to pay extra for in-the-office communications.

What makes the Pittsburgh trial even more exciting is imagining Personal Line folded together with other technologies BAMS is testing in other ma2rkets, such as data-on-cellular technologies from both CDI and CDPD (see page 14). BAMS has been offering another PCS technology from AccessPlus in Bellevue, Wash., for a while now in the Baltimore/Washington metro area under the name ContactLine. AccessPlus offers carriers a single-number service with a cornucopia of advanced features, such as selective call screening and voice mail. Another powerful feature puts a caller on hold while you are paged, then splices your inbound call -- from any phone -- to the original caller's. Truly spiffy.

> *We have friends who would like to buy their spouses cellular phones just in case they have a flat tire on the Cross-Bronx Expressway. Sort of an insurance policy against having to wander down a freeway in the rain at night, looking for one of those emergency phones. But $35 per month for an account and several hundred dollars for a device you hope never to use seems a tad extreme....*
>
> *What if cellular carriers were to offer a special account for occasional users? It would cost $1.50 per month, added to your phone bill. You could place only outgoing calls (relieving the cellular carrier of the worry and cost of tracking you), and you would be billed at three times the per-minute charges of normal (full-service) subscribers. You would use the same handset that you use, free of airtime charges, at home or in your office. It would just have an added use. Handy, eh?*

Eventually, Bell Atlantic plans to fold different services together into a broad menu from which people can choose what they want. Some services may fall out; others may be added. This strategy is typical of a cellular carrier today, though the precise mix of technology solutions varies.

The BAMS system works by extending the public cellular network indoors, which has its drawbacks. The pilot system uses Motorola's Personal Phone Service 800 (PPS 800), whose base stations and microcells are based on Narrowband AMPS, an enhanced version of the current analog cellular method of transmission in the US, called AMPS. Because the system shares the licensed frequencies with the cellular network, in-building systems must be engineered so as not to interfere with (or, more importantly, be interfered with by) the macrocell network. Also, the FCC views the base stations as mini cellular stations and requires that they be registered. The alternative is to use completely different technology for in-building work. For example, one could use...

...spread spectrum

There are two flavors of spread-spectrum radio technology. In the first, called frequency hopping (FH), transmitting units switch frequencies very quickly in a predetermined but secret sequence. Receiving units know the sequence and skip around at the same time, piecing together the message. Because the full-strength signal is sent at each of the frequencies, FH is subject to the same interference problems as a standard radio signal. It's just harder to intercept, so the military likes it.

The technology that will likely move us forward is called direct-sequence (DS) spread spectrum. This technology not only is hard to intercept but also allows many users to share a piece of spectrum that would not support such traffic using conventional methods. This means a new service (such as Data Freight, page 11) can coexist in the same bands that other casual operators use, without causing troublesome interference. DS can be used in licensed or unlicensed bands. It is just a transmission method.

Instead of moving a signal over a single small band of the spectrum, direct sequence technology diffuses the energy over a larger portion of the spectrum. It's like taking the water from a garden hose and sending it though a sprinkler: The same amount of water comes out, but in many small streams that are harder to intercept than one big one. With DS, not every sprinkler hole is active to send each message; transmitters and receivers agree on which of the holes will be carrying their particular signal, and monitor those exclusively. The set of sprinkler holes to watch at any given time is called the chipping sequence, because the information is broken down into "chips" that are spread over the appropriate frequencies. Now, other receivers and transmitters could be using several of the same holes, but few are likely to use the same subset. That is, by focusing on a specific subset of the frequencies, the receiving set can detect a signal amid the noise generated by other transmissions that share some of the frequencies.

Detection of the DS signals can be further explained with a cocktail-party metaphor. Notice how in a crowded party you can hear someone say your name from a distance, even if you aren't paying attention? Your name seems to jump out at you. Say you were at a very large cocktail party. If one person on the far side said your name, you probably wouldn't hear it. But if a certain number of people distributed across the room were to say it together, you could probably pick out your name. Some of those folks might be alternating saying your name with saying someone else's, but you would still hear your name above the din, especially if you could tune out all other speakers beyond the ones you've agreed to have carry the message. That's what direct-sequence spread spectrum does, dramatically oversimplified.

Omnipoint, the quiet company

There are few bona fide spread-spectrum experts in the world. Omnipoint, a privately held company founded in 1987 with backing from Allen & Co. (which also funded MCI and DSC), seems to have more than its quota of experts, and is involved in major projects everywhere. Omnipoint's engineers have been building gear for the military for many years. Not only did Omnipoint win an FCC Pioneer's Preference recently for PCS services, but its technology was used as part of the system for which cable operator Cox Enterprises won a PCS Preference, too.

Omnipoint's technology uses aspects of FDMA, TDMA and CDMA (frequency, time and code-division multiple access) all in the same system. Together, they can deliver a system that will support a large number of users over a broad space with very high quality voice transmission and little interference with neighboring systems. Omnipoint does this in licensed bands, such as the 1880-1950 band in which it currently has an experimental license, or in unlicensed bands, such as the 2.4 GHz band. In fact, Omnipoint is piloting a dual-mode handset that can operate in both bands: Outdoors, in "public" mode, it would use licensed spectrum from a public carrier; indoors, in "private" mode, it would use unlicensed spectrum (and no airtime charges!). Initial handset/base station combinations will cost from $1,000 to $1,500 per connection. So Omnipoint's system solves the wireless Centrex problem that haunts the Single Architecture scenario.

Doomed to Centrex?

Eliminating in-building charges will be more difficult for the PCS system BAMS is piloting in Pittsburgh (page 21). It is beyond foreseeable manufacturing technology to make a handset that will handle both NAMPS (for cellular use) and spread-spectrum (for free indoor use). Given the strategy of bringing the cellular network into the home and office, airtime charges seem inevitable. Omnipoint's band-switchable handset solves this problem.

WELCOME, JERRY MICHALSKI!

This issue marks the debut as contributing editor of Jerry Michalski, who has just joined us from New Science Associates, where he developed and ran the Intelligent Document Management and Continuous Information Environments services. His purpose here is to broaden our coverage to include new platforms as well as software, not to replace me. He is a distinct character with his own byline, and with distinct interests in the future of wireless communications, personal electronic devices, and connected computing in general. Jerry, who primarily advised users at New Science, will provide a fresh user-centered look at much of the technology we cover. Rather than sit in our office, he will mostly work from home and from the road, testing and depending on the connectivity systems and services we cover. (You can reach him anywhere by dialing 0 (700) CURIOUS on AT&T, or 10 (ATT) 0 (700) CURIOUS from other networks; this number is a story in itself.)

Our hope is that we will work separately and together as a complementary team, providing insight into the increasingly broad world of personal computing, which now extends well beyond pcs both onto global networks and into tiny, wearable devices. How do these small units self-organize into an increasingly connected world, both for businesses and consumers? We'll keep you informed with the latest iterations of our thinking -- always fresh, sometimes startling, always **Release 1.0**.

One other recent change merits note: the promotion of associate publisher Daphne Kis to publisher, in recognition of her key role in setting our strategy -- and in keeping the company running smoothly!

--- *Esther Dyson, editor*

RESOURCES & PHONE NUMBERS

Rob Euler, **Ardis**, (708) 913-1215; fax, (708) 913-4700
John Provinsal, **Bell Atlantic Mobile Systems**, (908) 306-7316; fax, (908) 658-3170
Lee Horsman, **Cellular Data Inc.** (CDI), (415) 856-9800; fax, (415) 856-9888
Steve Brendle, **Embarc**, (407) 364-3880; fax, (407) 364-3683
John Windolph, **Iridium**, (202) 371-6869
Mil Ovan, **Motorola**, (708) 632-3102; fax, (708) 632-3057
Jai Bhagat, **MTel**, (601) 944-1300; fax, (601) 944-7194
Brian Stout, **Omnipoint**, (719) 548-1200; fax, (719) 548-1393
Dick Brass, **Oracle Data Publishing**, (206) 637-8900; fax, (206) 323-6454
Gary Hughes, **Photonics**, (408) 955-7930; fax, (408) 955-7950
Ed Sharp, **RAM Mobile Data**, (201) 343-9400; fax, (201) 343-8795

COMING SOON

- *Simulation for education.*
- *Electronic data interchange.*
- *Pen stuff.*
- *Unified messaging.*
- *Performance support.*
- *Constraint-based reasoning.*
- *And much more... (If you know of any good examples of the categories listed above, please let us know.)*

Release 1.0 is published 12 times a year by EDventure Holdings, 375 Park Ave., New York, NY 10152; (212) 758-3434. It covers pcs, software, CASE, groupware, text management, connectivity, artificial intelligence, intellectual property law. A companion publication, Rel-EAST, covers emerging technology markets in Central Europe and the Soviet units. Editor: Esther Dyson; publisher: Daphne Kis; contributing editor: Jerry Michalski; circulation & fulfillment manager: Robyn Sturm; executive secretary: Denise DuBois; editorial & marketing communications consultant: William M. Kutik. *Copyright 1992, EDventure Holdings Inc. All rights reserved. No material in this publication may be reproduced without written permission;* *however, we gladly arrange for reprints or bulk purchases. Subscriptions cost $495 per year, $575 overseas.*

RELEASE 1.0 CALENDAR

November 11-14	**First general conference on nanotechnology** - Palo Alto. Sponsor: The Foresight Institute. Speakers include Marvin Minsky, Paul Saffo. Call Jane Nikkel, (415) 324-2490.
November 15-18	**IIA annual convention** - San Francisco. Sponsor: Information Industry Association. Call Holly Hospel, (202) 639-8262.
November 16-20	***Comdex** - Las Vegas. The biggest US show of all. With panel on information-sharing groupware with Chuck Digate (Beyond), Cyril Brookes (grapeVINE) and Jeff Conklin (CM/1) moderated by Esther Dyson. Contact: Peter Young at Interface Group, (617) 449-6600; fax, (617) 449-6953.
November 25-27	**OpenForum 92** - Utrecht, The Netherlands. Open systems exhibition and conference. Sponsored by EurOpen and UniForum. Contact: Mark Weber, (708) 260-9700; fax, (708) 260-0395 or Marjolein Jacobs, 31 (30) 955662; fax, 31 (30) 955539.
Nov 30-Dec 4	**Hypertext '92** - Milan, Italy. Sponsored by ACM. Contact: Julie Eitzer, (212) 626-0604; Paolo Paolini, 39 (2) 2399-3520; e-mail, paolini@ipmell.polimi.it.
December 2-5	**Entrepreneurial technology transfer: The commercialization success factors for intra- and entrepreneurs** - Baltimore. Sponsor: MIT Enterprise Forum. With John Seely Brown, Sheryl Handler. Call John Preston, (617) 862-0397.
December 7-8	**The personal computer outlook** - San Francisco. Sponsored by Technologic Partners. Call Leslie Ip, (212) 696-9330.
December 8-11	**New York Technology Summit** - New York City. Conference and exhibits on telecommunications, networks, computing. Sponsor: American Expositions. Call Joanne Turner, (212) 226-4141.

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January 25-29	**PenExpo** - San Francisco. Co-sponsored by Boston University Corporate Education Center and PenWorld. Or should it be MobilExpo? Call Tom Zaralides, (508) 649-6926 or (800) 733-3593.
Jan 31-Feb 3	***Demo '93** - Palm Springs. Sponsor: InfoWorld Editorial Products Group. Call Tracy McGee, (415) 312-0545.
February 21-24	****EDventure Holdings PC (Platforms for Computing) Forum** - Phoenix (*not* Tucson). "Content is key." You read the newsletter; come meet the players and try out some of the gadgets and services described in this issue. The usual suspects, plus speakers Dick Brass, Tom Ray, Jeff Hawkins, Vern Raburn... Call Daphne Kis, (212) 758-3434.
February 21-26	**Software Development '93** - Santa Clara. Sponsored by Miller Freeman. Call KoAnn Tingley, (415) 905-2741.
March 1-5	***AI for applications conference** - Orlando. Sponsor: IEEE. Call Bernadette Minton, (415) 688-8607.

March 3-7	***SPA spring symposium** - San Diego. Sponsored by Software Publishers Association. Call Karen Johnson, (202) 452-1600.
March 9-12	***Third Computers, Freedom and Privacy conference** - San Francisco. Communication, privacy and the global network: Social responsibility can be fun! Sponsored by ACM. Call Bruce Koball, (510) 845-1350.
March 15-19	**UniForum 1993** - San Francisco. Sponsored by UniForum Association. Call Ed Palmer, (408) 986-8840 or (800) 2555620.
March 24-31	**CeBIT '93** - Hannover, Germany. Sponsor: Hannover Fairs USA. Everything you're interested in, and a lot more. Call Mette Fisker Peterson, (609) 987-1202; Geide Schlichting, 49 (511) 89-0; fax, 49 (511) 89-3 2626.
March 28-31	**ITAA spring management conference** - Orlando. Sponsor: Information Technology Association of America. Call Shirley Price, (703) 284-5355.
Mar 31-April 3	**Seybold Boston** - Boston. Electronic publishing in all its glory. Sponsored by Seybold Seminars. Call Beth Sadler or Kevin Howard, (310) 457-5850.
April 18-23	**Marathon Week** - Boston. Sponsor: Patricia Seybold's Office Computing Group. Open Systems Forum, Seybold Executive Forum and Distributed Object Computing Technology Forum. Call Deborah Hay, (617) 742-5200 or (800) 826-2424.
April 19-23	**Object Expo** - New York City. Sponsored by SIGS Publications. Call Cindy Baird, (212) 274-0640.
April 24-29	**INTERCHI '93: Human factors in computing systems** - Amsterdam. Interfaces and intelligibility. Sponsored by ACM. Call Carol Klyver, (415) 738-1200.
April 25-28	**World Computer Law Congress '93** - San Diego. Sponsor: Center for Computer Law. Call Michael Scott, (213) 689-5186.
May 4-6	**LotusWorld** - Boston. Sponsored by Danieli & O'Keefe Associates. Call Jackie Rawlings, (508) 443-3330.
June 6-9	***SPA Europe's annual conference** - Cannes. Sponsored by Software Publishers Association. Contact: Ken Wasch, (202) 452-1600; fax, (202) 223-8756; Vivianne Lemonnier, 33 (1) 4692-2703; fax, 33 (1) 4692-2531.
July 11-16	**AAAI/IAAI 93** - Washington, DC. Sponsored by The American Association for Artificial Intelligence. Call Carol Hamilton, (415) 328-3123.
October 25-29	***INTEROP 93** - Paris. The mother of all networking conferences, now global. Sponsor: Interop Europe. Contact: Carinne Propper, 33 (1) 4639-5656; fax, 33 (1) 4639-5699.
November 15-19	***Comdex** - Las Vegas. Start planning for next year! Contact: Peter Young at Interface Group, (617) 449-6600; fax, (617) 449-6953.

Please let us know about events we should include. -- Denise DuBois

**The asterisks indicate events we plan to attend. Lack of an asterisk is no indication of lack of merit.*

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Daphne Kis
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